Hybrid Truck Users Forum - HTUF™
A Process for Fleet and Industry

Advanced Transportation Technologies

Clean Transportation Solutions SM

Bill Van Amburg
Senior Vice President

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Hybrid Truck Introduction Timing

2006 2007 2008 2009

HTUF Working Groups

- Utility 24 trucks deploy
- Delivery WG Pre-Production (15-30)
- Refuse WG Pre-Production (15-30)
- Utility Truck First Production (100)
- Utility Truck Next Phase (500+)
- Food Delivery Class (15-50)
- Shuttle/Paratransit (15-50)

Industry Launches

- FedEx II (75)
- FedEx III (75)
- Purolator II (115)
- UPS I

Product Releases

- Allison & BAE Bus Driveline production?
- International/Eaton 1st Production
- Freightliner CC/Eaton 1st Production?
- Azure 1st Production
- Peterbilt/Eaton 1st Production?
- Volvo 1st Production

Estimated Volumes

150+ *400+* *2000* *5000*

Transit hybrids not included

Agenda

- Truck World Is Changing
- HTUF Model for Change
- First Successes
- Next Steps

Truck World is Changing

HTUF National Meeting 2005

- *275+ attendees*
  - *One quarter fleet*
- *13 med. & heavy hybrid vehicles*
- *3 Working Group Meetings*
- *EPA hybrid testing meeting*

Dana Technical
Resource Park

Recent Hybrid News

- Volvo announces hybrid heavy trucks planned for 2009 production
- FedEx adds 75 hybrid delivery vans, plans to then add 75 more; UPS commits to 50; Purolator orders 115 more Azure hybrid delivery vans
- NYC orders 500 more Daimler Chrysler (Orion/BAE) hybrid transit buses
- GM, DCX to partner on hybrids
- Transit bus hybrid order/deliveries between 1000-2000 units
- International/Eaton report 40-60% fuel reduction in hybrid utility truck
- Dana/PermoDrive partner on commercial hydraulic hybrid vehicles (refuse target)
- Eaton unveils hydraulic hybrid shuttle bus

Pre-Production & First Products

- International: ready for first commercial production of Class 5-7 hybrid electric trucks in late 2006
  - Announced at HTUF National Meeting
- Peterbilt testing hydraulic hybrid refuse truck (63,000 pound GVWR)
- Pre-production in 2006
- Azure parcel delivery and shuttle bus platforms – early production in late 2006
- Volvo Trucks announces 2009 production plans

Why Hybrids Are Gaining Traction with Fleets

- Rising fuel costs: Optimizing urban truck drivelines is becoming critical for fuel efficiency, emissions
- Major engine changes – and increased cost/complexity – coming in 2007-2010 to comply with EPA emissions requirements
- Trend toward integrated engine/drivelines in trucks
- Increasing electrical power needs in heavy vehicles and equipment
- Idle Management is a growing issue
- Productivity/performance complaints from cleaner engines

Hybrid Truck Users Forum:
A Process for Commercialization

Hybrid Truck Users Forum (HTUF)

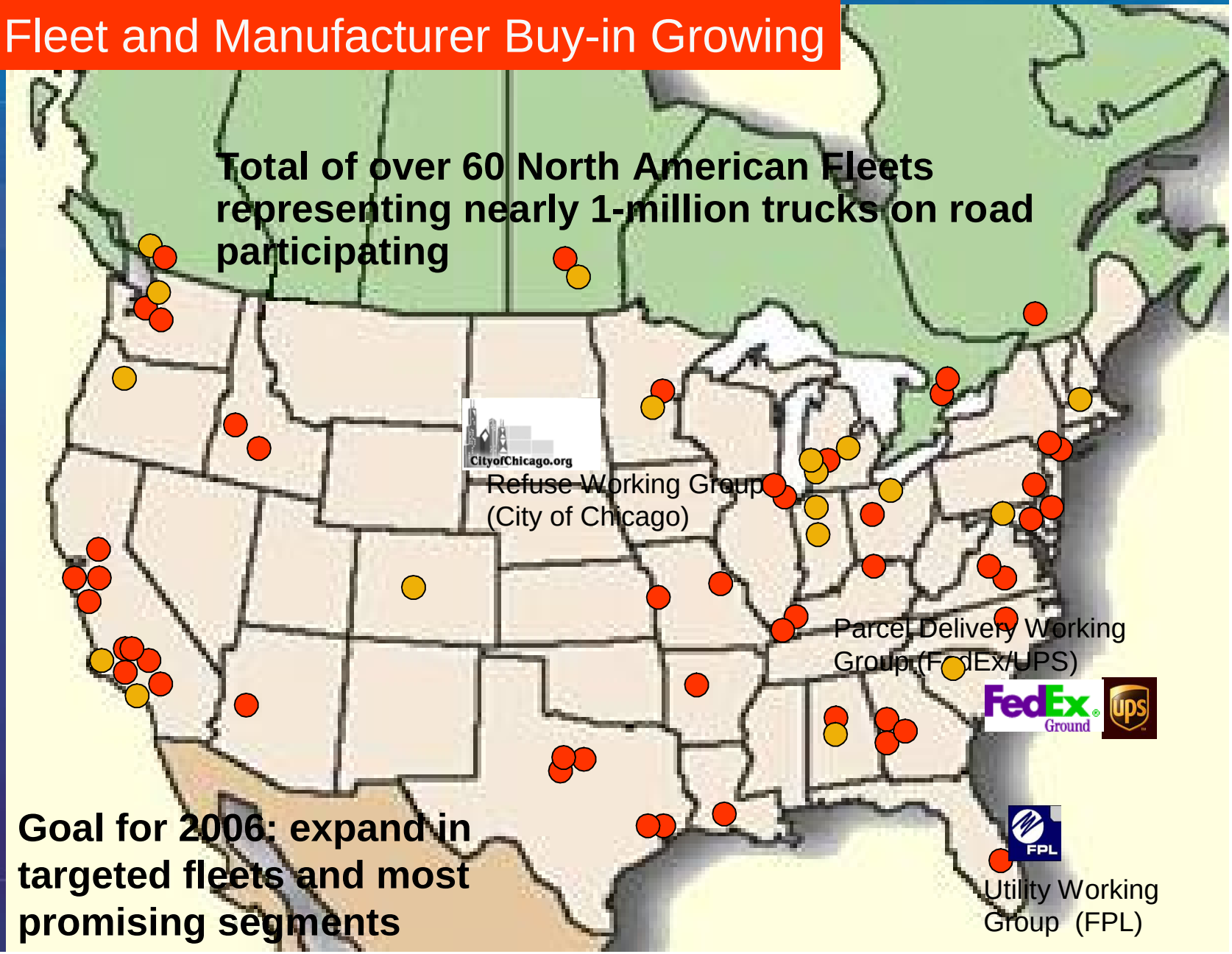
- **User-driven process** to facilitate the commercialization of medium- and heavy-duty hybrid trucks in the U.S.
- Joint WestStart-U.S. Army/NAC program
- Also supported by Hewlett Foundation
- HTUF focuses on commercializing hybrid trucks with dual-use benefits; helping speed commercialization and lower overall costs (leveraging investments)
- Army supports because wants to see commercial hybrid market to lower costs

HTUF: User-Based Program Expands

Fleet and Manufacturer Buy-in Growing

Selected OEM/ Supplier locations shown

Selected fleet locations shown



•Beverage Company

- •Coca Cola Sacramento
- •Danone Waters
- •Perrier (Nestles Water Group)
- •Pepsico/Frito-Lay
- •Yosemite Waters

•Refuse

- •Waste Management
- •Los Angeles Dept of General Services
- •New York City Sanitation
- •Houston Sanitation

•Government Agency

- •Canadian Army
- •General Services Administration
- •Idaho National Energy labs
- •San Joaquin Valley Clean Cities
- •United States Army
- •United States Army Aviation
- •United States Air Force

•Parcel/Mail Delivery

- •FedEx Express
- •FedEx Ground
- •United Parcel Service
- •United States Postal Service
- •DHL Worldwide Express
- •Purolator Courier

•Less Than Load & Regional Delivery and Line Haul

- •American Trucking Association (TMC)
- •Ryder Transportation Services
- •Schneider National
- •Wal-Mart Transportation
- •Enterprise Truck Rental
- •GE Fleet Services

•Grocery Chain

- •Safeway/Vons
- •Kroger

•University

- •Indiana University Motor pool

•Power Company/Utilities (over 25)

- •Alabama Power
- •AEP
- •Baltimore Gas & Electric
- •Duke Energy
- •Electric Power Research Institute
- •Florida Power and Light
- •Illinois Power
- •New York Power Authority
- •Pacific Gas and Electric
- •Southern California Edison
- •Tennessee Valley Authority
- •Memphis Light Gas and Water
- •Georgia Power
- •Gulf Power
- •Los Angeles Dept of Water and Power
- •Sacramento Municipal Utility District
- •TXU

HTUF Member Fleets

(partial list)

Focus Area for HTUF: Top Early Hybrid Applications

"Beach Head" Markets Show Best First Promise

Class 7/8 Refuse trucks

Class 3-6 Urban delivery trucks

-package delivery

-beverage delivery

Specialty Truck Applications (Class 4-7)

-Utility "Bucket" trucks

-Telecom/cable trucks

Class 6-8 Heavy Urban delivery trucks

-regional heavy distribution (beverage, grocery, postal)

HTUF Working Groups

- **4 Working Groups of fleet truck users now operating**
  - **Utility/Specialty trucks – George Survant, Florida Power & Light, lead**
  - **Parcel Delivery trucks – Sid Gooch, Fed Ex Express; Bob Dengler, FedEx Ground; Robert Hall, UPS – user leads**
  - **Refuse Truck Working Group – *User lead City of Chicago Sanitation***
  - **Bus Working Group – *launched with support of Federal Transit Administration***

Market and Tech Linkages for Medium and Heavy Hybrids

Three Key Markets Work Together Through HTUF

Military

Early investment $
Lower volumes
Toughest “spec”

HTUF identifies cross market linkages in requirements, platforms and drivelines that can increase overall volumes

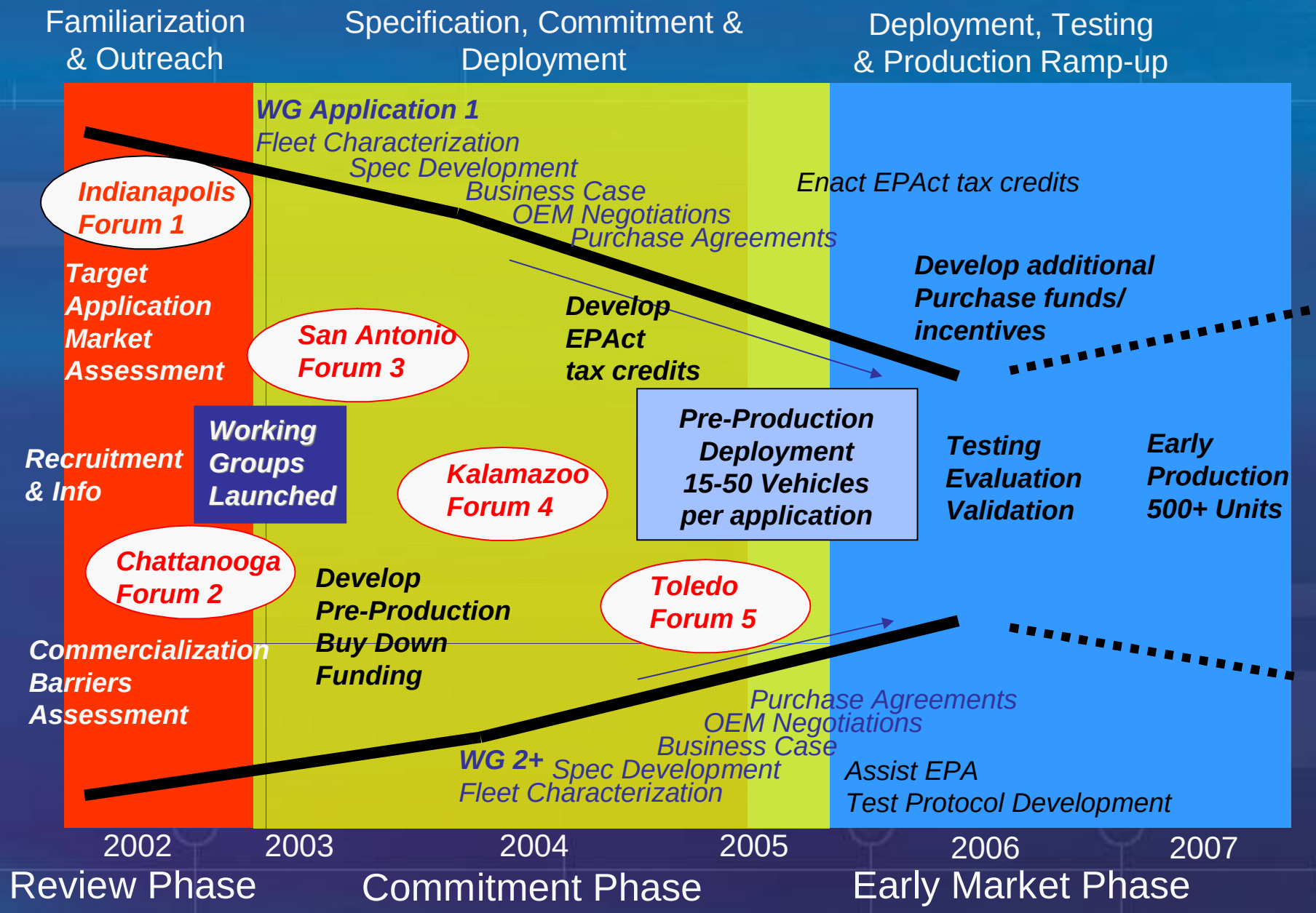
Commercial Truck

Highest volumes
Later to market
Toughest economics

Bus

First to Market
Long life cycle
Low volumes

HTUF "Commercialization Funnel"



First Successes

First HTUF Commitment: Hybrid Electric Utility Truck

HTUF Utility Working Group Jointly Agreed to Pre-Production Purchases

Similar Driveline to Class 5-7 truck, FMTV, shuttle bus markets

Class 6/7
Hybrid Electric
40-60% Fuel Economy Improvement
Greatly Improved Total Emissions
Idle Reduction (shuts off at work site)
25 kW power export
Meets or exceeds driving performance requirements
24 pre-production trucks to be assessed in 14 fleets

North American Deployment & Assessment

Data Will Assist Commercial & Military Hybrid Decisions

HTUF Utility Hybrid Working Group

24 Truck Deployment Locations

Hybrid Testing Complete

- Tested the validator hybrid truck against similar baseline truck over representative utility truck duty cycles
- Baseline truck 2004 International 4300 with 215 hp engine, Allison automatic transmission
- Tested on chassis dynamometer for driving portion of duty cycle and stationary in work portion
- **Overall results are better than expected for duty cycle results**

Four Duty Cycles Tested

- Used four duty cycles (Missions) proposed by supplier team in proposal
- Represents standard use of trucks by utilities
- Mixes driving and work site operations into total duty cycle

Four “Missions”

- Mission A
  - 70 miles driving; 3 service/site calls; 1.5 hours hydraulic operation (cycle 1)
- Mission B
  - 70 miles driving; 3 service/site calls; 1.5 hours hydraulic operation (cycle 1); 1.5 hours 2 kW
- Mission C
  - 48 miles driving; 3 service/site calls; 3 hours hydraulic operation (cycle 1)
- Mission D
  - 38 miles driving; 2 service/site calls; 3 hours hydraulic operation (cycle 2)

Fuel Use by Mission

Fuel Use Reduction Over Baseline:

- Mission A – **40%** reduction in fuel use
- Mission B – **38%** reduction in fuel use
- Mission C – **58%** reduction in fuel use
- Mission D – **60%** reduction in fuel use

What Do The Results Mean?

- Trouble Truck "Duty Cycle" Model
  - 3 stops @ 1 ½ hour per stop and 70 mile drive for an 8 hr. day
    - 40% consumption reduction in fuel
    - At $2.70/gal. Predicted annual fuel savings of $3,500

- Crew Truck (Severe) "Duty Cycle" Model
  - 2 stops @ 3 hours per stop and 38 mile drive for an 8 hr. day
    - 60% consumption reduction in fuel
    - At $2.70/gal. Predicted annual fuel savings of $4,500

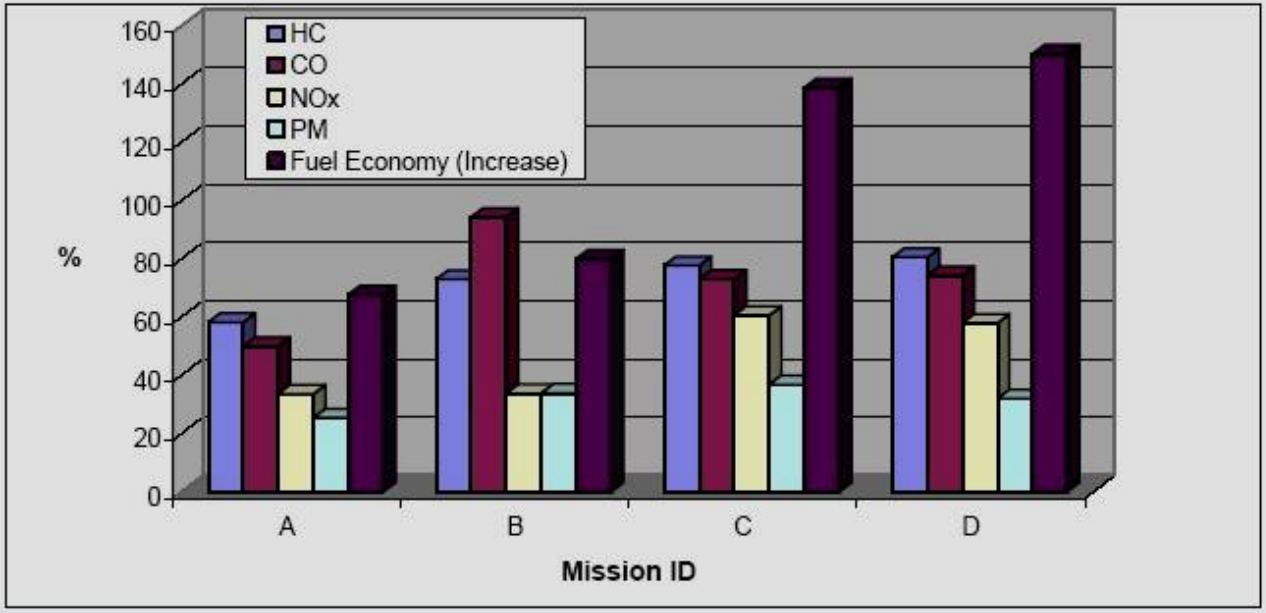
Emissions Reductions by Mission

Reductions just from hybrid system, no additional after treatment

CO2 reductions closely tracked fuel reduction percentages

TABLE 10 AND FIGURE 9. PERCENT DECREASE IN RATE OF EMISSIONS (g/hr) AND PERCENT INCREASE IN FUEL ECONOMY (mpg) OBTAINED BY USING THE HEV TRUCK COMPARED TO THE BASELINE USING FOUR EATON-SPECIFIED MISSION CYCLES

Mission Cycle ID (given in Table 8)	HC (g/mi) %	CO (g/mi) %	NOx (g/mi) %	PM (g/mi) %	Fuel (mpg) % (increase)	Miles Driven	Hours of Operation (hydraulic + electric)
A	58	50	34	25	68	70	1.5
B	73	94	34	34	80	70	4.5
C	78	73	61	37	139	48	3
D	80	74	58	32	150	38	3



Additional Working Group Activities

- **Parcel Delivery Working Group -** Involvement from key national fleets
  - *(including FedEx Ground; UPS; USPS; FedEx Express; Corporate Express; Purolator)*
- Putting together business case and joint purchase RFPs for **hydraulic hybrid** in Class 4 (14,000 lb GVWR) and Class 6 (22,000 lb GVWR) – RFI on street now

Heavy Parcel Hybrid Similar Size as FMTV, New FTTS Platform

- **Refuse Working Group**
- 8 major fleets to date including private and municipal players
  - (Waste Management; Onyx; Cities of New York, Houston and Chicago)
- Productivity as important as fuel econ.

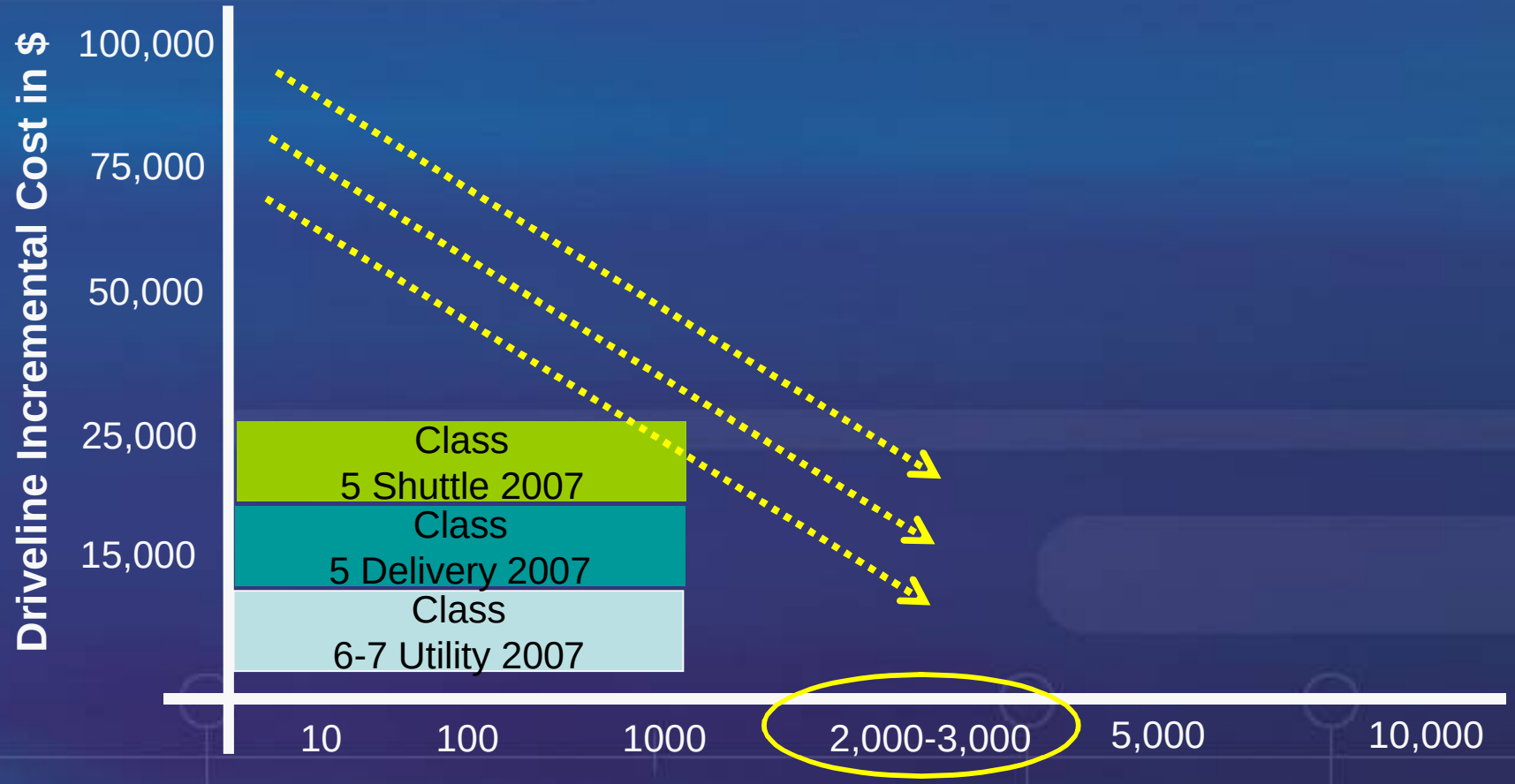
Bus Working Group

- Urban heavy transit hybrid bus market growing: 1000-2000 on road/in delivery
- Formed WG to assist faster growth of hybrid transit bus and supporting markets
- 15 transit properties participating; have drafted a hybrid business case for urban transit to share with policy leaders
- Expansion to shuttle and paratransit buses that use truck chassis

Next Steps

What's Next?

Increase Volumes in Markets With Similar Drivelines to Lower Costs



Hybrid Business Case

- Operational Savings
  - Fuel (the higher fuel goes, the shorter the payback)
  - Maintenance
  - Extended engine life
- Productivity Gains
  - Faster Launch from Stop, More Effective Braking
  - Idle Reduction – engine shut off
- Emission Reductions
- Incentives
  - EPAct HD hybrid incentives
  - Regional/state funding grants and incentives

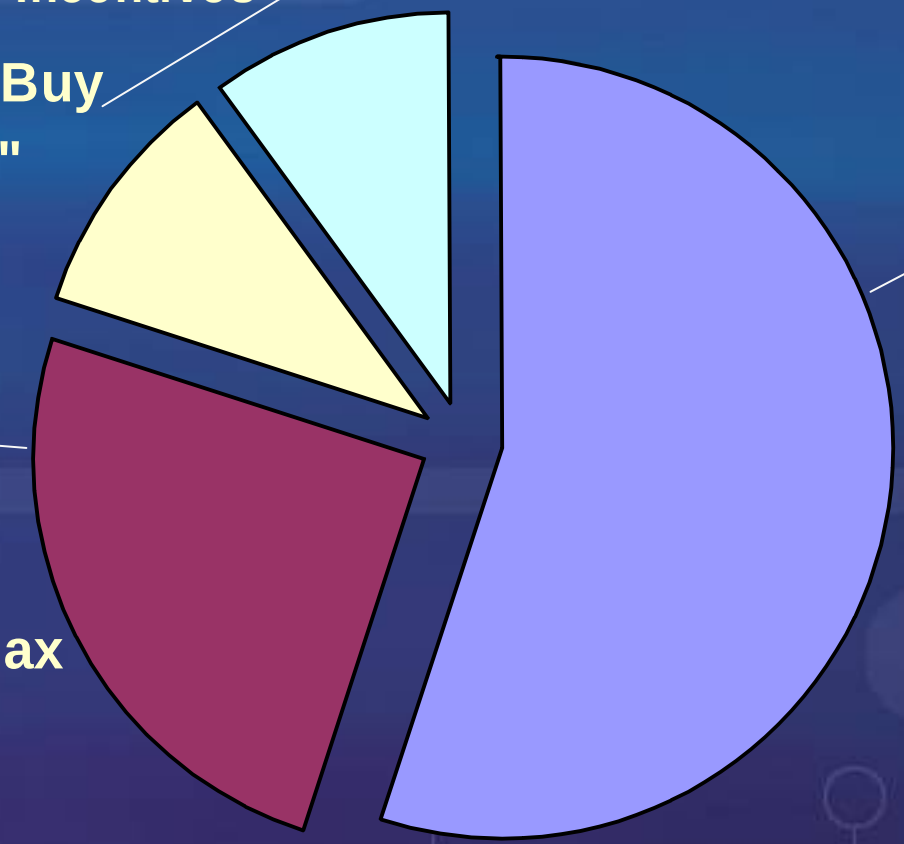
EPAct National HD Hybrid Tax Credits

- Credit is based on weight of vehicle and fuel efficiency gains of hybrid system
- Provides increasing credit for greater efficiency
- Limits incremental cost
- *Credit available for five years starting in 2005*

Vehicle weight	Maximum Tax Credit for 30% Fuel Economy Increase*	Maximum Tax Credit for 40% Fuel Economy Increase*	Maximum Tax Credit for 50% Fuel Economy Increase*
8,501 – 14,000 lb	$1,500	$2,250	$3,000
14,001 - 26,000 lb	$3,000	$4,500	$6,000
>26,000 lb	$6,000	$9,000	$12,000

** based on maximum qualified incremental cost*

Hybrid Incremental Cost – The "Wedges"



Hybrid Choice Criteria

- Know your duty cycle (driving and work components)
  - Type of driving
  - Idle time, in traffic and work site
- Understand your key costs
  - Fuel and fuel delivery
  - Maintenance
- What is value of performance gains to your mission?
  - More pickups per day?
  - Quiet operation at work site?
  - Additional emission reductions?
- Payback should be looked at based on total cost of ownership, not simple payback
- Leadership

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Clean Transportation Solutions [SM]

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www.weststart.org

For info contact:

Bill Van Amburg
(626) 744-5600
bvanamburg@weststart.org

www.htuf.org